GOVERNMENT REVIEW

OF THE

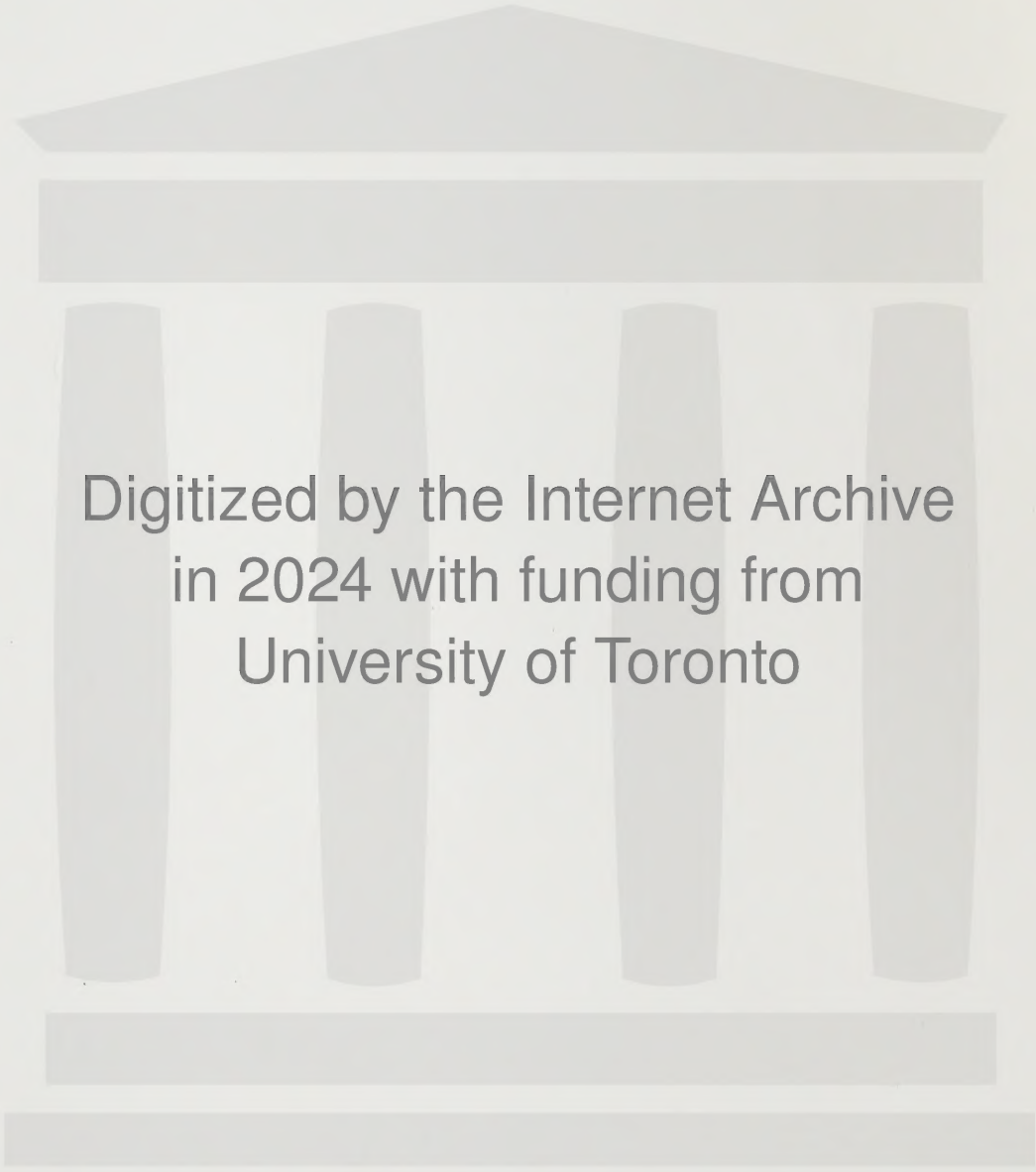
COUNTDOWN COMPANIES'

1991 ACID GAS EMISSIONS AUDITS

AUGUST 1993

Ontario

Ministry of
Environment
and Energy



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Air Resources Branch and Northeastern Region

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EXECUTIVE SUMMARY

A verification program was implemented in 1990 to ensure that the reported emissions to the Ministry of Environment and Energy (MOEE) from the major emitters of Sulphur Dioxide (SO_2) and Nitric Oxide (NO) were accurate, reliable and verifiable. This verification program was applied to four major Countdown Acid Rain SO_2 emitters: metallurgical companies INCO Limited, Falconbridge Limited and Algoma Steel Inc. (Wawa Operations), and Ontario Hydro's fossil fired generating plants. These four emitters were regulated under Ontario's Countdown Acid Rain Program Regulations and, to meet further requirements, by Director's Orders under section 18, Environmental Protection Act R.S.O. 1990.

These Regulations required several abatement measures. INCO Limited was to limit annual SO_2 emissions to 685 kilotonnes (kt) from 1986 to 1993 and 265 kt by December 31, 1994, and conduct an investigation into further reducing the annual emissions to 175 kt (Regulation 660/85). Falconbridge Ltd. was regulated to meet an annual SO_2 emission limit of 154 kt from 1986 to 1993 and 100 kt beyond 1993, and Algoma's Wawa operation was limited to 180 kt from 1986 to 1993 and 125 kt beyond 1993 (Regulations 661/85 and 663/85). Ontario Hydro's combined fossil fuel generating plants were required, in aggregate, to meet SO_2 emissions limits of 240 kt from 1990 to 1993 and 175 kt beyond 1993, and combined SO_2 and NO emissions limits of 280 kt from 1990 to 1993 and 215 kt beyond 1993 (O. Reg. 355/90, formerly O. Reg. 281/87).

The Section 18 Director's Orders required the companies to prepare and submit Sulphur Mass Balance Procedures manuals, determine the overall uncertainty of their respective annual emissions and engage an independent auditor to develop an Audit Protocol Manual and conduct audits of the reported emissions. In the case of Ontario Hydro, the auditor was also required to evaluate the continuous flue gas monitoring systems.

The auditors confirmed, by conducting a comprehensive audit of the procedures in 1991, that the three metallurgical companies' reported emissions were within the emissions limits as required by their respective Regulations. There were no deviations from the procedures that affected the calculated emissions. In the case of Ontario Hydro, the audit also confirmed that both SO_2 and NO emissions were within the limits for 1991 as required by its Regulation. The auditor also indicated that there were no major discrepancies with the procedures manual(s) that affected the calculated SO_2 and NO emissions.

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1. INTRODUCTION

An acid gas emissions verification program was implemented in 1990, as part of the Countdown Acid Rain Regulation Program. This verification program was to apply to four designated Countdown companies, namely the metallurgical companies INCO Ltd., Falconbridge Ltd. and Algoma Steel Inc. (Wawa Operations), and Ontario Hydro's fossil fired generating plants. These four emitters were regulated under Ontario's Countdown Acid Rain Program Regulations, and further directed under Section 18 Directors' Orders of the Environmental Protection Act R.S.O. 1990 (formerly Section 17).

The Countdown Acid Rain program limits the acid gas emissions for the top four emitters, as summarized according to the following schedule:

Ontario's Countdown Acid Rain Program

Annual Limits for Acid Gas Emissions*
Kilotonnes (Kt)

	YEAR			
COMPANY	1986	1990	1994	(& beyond)
INCO Limited	685	685	265	
Ontario Hydro	430	280	215	Acid Gas (SO_2 plus NO)
	370	240	175	
Algoma Steel	180	180	125	
Falconbridge Limited	154	154	100	

* For SO_2 except where noted otherwise.

The Director's Orders issued under Section 18 of the Environmental Protection Act R.S.O. 1990 also required the emitters to prepare and submit Sulphur Mass Balance Procedure manuals, determine the overall uncertainty of their respective annual emissions and engage an independent auditor to develop an Audit Protocol Manual and to conduct audits of the reported emissions. The auditors were required to evaluate and comment on the sulphur mass balance (SMB) procedures used to determine that the SO_2 and NO emissions reported to the Ontario Ministry of Environment and Energy were verifiable, accurate and reliable.

2. BACKGROUND ON EMISSIONS VERIFICATION PROGRAM

This verification program was developed to determine and ensure the reliability and accuracy of the reported emission figures to the MOEE. In the 1987 Provincial Auditor's report[1], concerns were expressed that the emission figures reported by the major acid gas emitters were not being verified by the Ministry. A sub-committee of the Countdown Technical Support Group was formed in December 1987, comprising of representatives from the Ministry's Air Resources Branch, Northeastern Region and Acid Precipitation Office to evaluate and develop a verification program. In February of 1988, the sub-committee awarded three contracts to evaluate existing methods and develop a verification program consisting of the following elements:

1. Review and evaluate the suitability, accuracy and precision of the existing estimation methodology used to determine annual emissions.

2. Review and document the adequacy of the testing and sampling procedures, equipment and analytical methods currently used in determining annual emissions.

3. Recommend, if appropriate, improvements to the existing estimation methodology to ensure that the emission figures are accurate and reliable.

4. Recommend a procedure to independently audit the emission data, including the frequency, number and location of the samples and measurements needed, along with the time requirements, to yield a scientifically and statistically valid verification.

5. Recommend appropriate reporting procedures to be used.

The consultants concluded that current emissions estimating methods were acceptable. These methods include the direct flue or stack measurements of pollutants, flue gas monitoring of combustion parameters and the SO_2 and NO mass balance estimating methods. The metallurgical companies also use a mass balance method for production and metal accounting purposes. In the case of Ontario Hydro, it was recommended that the current mass balance method for SO_2 emission estimation be upgraded to methods prescribed by the American Society for Testing and Materials (ASTM) for sampling and analysis or an equivalent method. It was further recommended that the NO versus electrical output curves used to generate the NO emission estimates be also upgraded. Process information on fuel consumption (sulphur content of coal and oil) and combustion products is also used in the SO_2 and NO mass balance determinations. The NO emissions estimated are determined by multiplying the derived NO concentration factor by a flue gas volume flow, based on fuel consumption. NO emission varies with boiler operating parameters, e.g., load, excess oxygen, fuel quality and boiler types.

All consultants recommended that the existing mass balance procedures be retained and upgraded to ASTM industry standards, documented in a procedures manual and that these procedures be audited.

The sub-committee identified two other methods for acid gas emission verification. These methods were identified as Continuous Emission Monitoring (CEM) and parallel estimation. The parallel estimation method consists of duplicating everything the company was doing to estimate acid gas emissions. Of these two methods, parallel estimation was considered too costly, a duplication of efforts and could result in significant variation in emission estimates. For these reasons, the parallel estimating method was not considered further. CEM, however, was considered as a viable option. This method, pioneered in the United States (U.S.) to meet New Source Performance Standards (NSPS), could provide an acceptable option to the SMB method. The system consists of instruments which continuously measure the concentration of SO_2 and NO, and flow rate in the main flue gas stream. An electronic data handling system then converts this information to emission rate and provides periodic reports (hourly, daily, etc.) in the form of hard copy or digital outputs. The quality of these systems has significantly improved in the past 10 years, with a marked increase in the degree of confidence, accuracy and reliability. The U.S. EPA regulations are very explicit when describing the installation, commissioning and auditing of CEM systems [2]. CEMs are required on all new power plants in the United States.

Based on technological developments, costs of implementation, process limitation and accuracy of reported emissions, the sub-committee made several recommendations in 1989.

For the three metallurgical companies:

* An audit of SMB procedures was to be implemented within one year.

* A SMB procedures manual was to be developed by the companies and accepted by MOEE.

* An independent audit was to be performed by a qualified engineering consultant and the cost paid by the companies.

* The consultant's audit was to be coordinated and overviewed by MOEE for the metallurgical companies.

* INCO and Falconbridge were requested to undertake a feasibility study on using CEM systems to report quarterly or annual emission quantities.

For Ontario Hydro:

* The analytical methods were to be upgraded to American Society for Testing and Materials (ASTM) or proven equivalent. Further, the SO_2 and NO mass balance procedures were required to be documented, the NO estimation method was to be updated and a status report was to be provided to the Ministry within three months.

* Ontario Hydro was required to examine alternative acid gas measuring systems and submit a report in six months commenting on the following:

  . quantitative accuracy and precision;
  . details on capital and operating costs;
  . operating benefits of systems;
  . preference of the estimating method for each unit and implementation schedule.

  In developing these reports Ontario Hydro was required to consult with the Ministry.

* Following MOEE approval, Ontario Hydro was to have installed a measuring system or systems according to the schedule and submit quarterly progress reports.

* Independent audits were to be performed quarterly by a qualified engineering consultant and the cost paid by Ontario Hydro.

* The progress of the gas measuring systems and auditing of the emissions was to be coordinated by the Air Resources Branch in co-operation with other Ministry staff.

3. DIRECTOR'S ORDERS

Subsequent to the work completed by the sub-committee, a new working group was formed in March 1990. This group was to recommend an emissions verification program for the four regulated emitters under Ontario's Countdown Acid Rain Program. The group consisted of representatives from the Air Resources Branch, Laboratory Services Branch, Northeastern Regional Office and Acid Precipitation Office (presently part of the Air Resources Branch). This verification working group developed Director's Orders under Section 18 of the Environmental Protection Act, Revised Statutes of Ontario, 1990, Chapter 141. Four separate Director's Orders were developed and served on INCO Limited, Falconbridge Ltd., Algoma Steel Inc. and Ontario Hydro in June and July of 1990.

The following is a summary of the important features of these Director's Orders:

1. A Procedures Manual was to be developed based on ASTM methods or equivalent industry standard for sampling, weighing and analyzing various streams of sulphur containing materials or process streams for use in the material balance calculation to estimate annual SO_2 emissions.

   The NO emissions were to be estimated from NO versus load curves for each operating boiler.

2. A qualified independent engineering consultant acceptable to the Ministry was to be selected to undertake the following tasks:

   (a) to develop an audit protocol manual;

   (b) to conduct mass balance procedures emission audits, starting in 1991, to ensure compliance of the Regulations by these four major emitters;

   (c) to check randomly the SMB procedures and select key samples to verify the sulphur content.

3. The metallurgical companies, except for Algoma Steel Inc.'s Wawa operation, were requested to develop and undertake a feasibility study on using CEM for measuring and reporting SO_2 emissions and to compare the data with mass balance calculating method results. In the case of Falconbridge Limited, an interim feasibility study report is to be submitted by June 1993, with the final study report by December 31, 1993. INCO Limited is to submit a Term of Reference for the CEM study by October 29, 1993, and an interim and final study reports by June 30 and December 30, 1994, respectively. These studies are to coincide with the completion and break-in period of the new smelter process and equipment changes.

4. Ontario Hydro was requested to submit a detailed plan for acceptance, on how to upgrade the existing system to measure continuously SO_2 and NO concentrations, and flue gas velocity or equivalent parameter. Periodic progress reports must be provided on the measuring systems used for each fossil fuel burning boilers.

5. Prior approval was to be obtained before making changes to the SMB procedures and emission estimating methods.

6. The Audit Protocol Manual required acceptance before commencing the 1991 emissions audit.

7. Schedules were specified to meet the various requirements of the Director's Orders.

4. IMPLEMENTATION OF DIRECTOR'S ORDERS

Implementation of the Director's Orders requirements commenced in July 1990 and the progress is summarized below:

(a) INCO Limited

- The company has implemented most of the requirements of the Order.
- The statistical analysis method to be used for estimating the

uncertainty of the reported annual SO_2 emissions needs further refinement.

- Price Waterhouse, in association with ORTECH International, was selected and accepted to undertake the following:

  (i) to develop an audit protocol procedures manual for the SO_2 emissions verification program; and

  (ii) to audit the 1991 SO_2 emissions.

(b) Falconbridge Limited

- The company has met the requirements of the Director's Order.
- The Procedures Manual, along with the statistical analysis methods for estimating the uncertainty of the reported SO_2 emissions, has been accepted.
- Hatch Associates Ltd. was selected to develop the audit protocol manual and conduct the 1990 and 1991 SO_2 emissions audit.
- A preliminary (trial) audit of 1990 SO_2 emissions was undertaken, covering major input and output streams of the SMB. This audit confirmed that the reported 1990 SO_2 emissions were 69.6 kt. with an uncertainty of ±6.9%, at the 95% confidence level.

(c) Algoma Steel Inc. (Wawa)

- The company has met the requirements of the Director's Order.
- The Procedures Manual, along with the statistical analysis methods for estimating the uncertainty of the reported SO_2 emissions, has been accepted.
- Rowswell & Associates Engineers Ltd. has been selected to develop the Audit Protocol Manual and conduct the 1990 and 1991 SO_2 emissions audit.
- A preliminary (trial) audit of the reported 1990 SO_2 emissions confirmed the emission to be 43.0 Kt with an uncertainty of ±5.2%, at the 95% confidence level.

(d) Ontario Hydro

- The corporation has met the audit requirements of the Director's Order.
- The Procedures Manual used for estimating SO_2 and NO emissions has been developed and accepted by the Ministry.
- The reported accuracy of the coal sampling and sulphur analysis has been confirmed by an independent engineering consultant using statistical analysis methods. The consultant confirmed that the annual average sulphur content of coal derived from current sampling, weighing and analysis practices yields an uncertainty of ±0.04%. The consultants also recommended that a comprehensive quality assurance program be implemented for all laboratory operations.

- Angus Environmental Ltd., a consulting engineering firm, was selected to undertake the following:

  (i) to develop an audit protocol procedures manual for the SO_2 emissions verification program;

  (ii) to audit the 1991 SO_2 and NO emissions on a quarterly and annual basis.

- Ontario Hydro has elected to install flue gas monitors (FGMs) to continually measure the SO_2 and NO concentrations in the flue gas for all currently operating boilers. Presently, these FGMs systems are being tested for SO_2 and NO measuring reliability and accuracy. If accuracy proves superior to the material balance method, future reporting of emissions could be based on the FGMs method.

- Ontario Hydro is also comparing the performance of the FGM unit to an in-stack CERM (Continuous Emission Rate Monitoring) System at the Nanticoke Station. This comparative study, planned for 1993, is expected to take six months.

- SO_2 and NO emissions will continue to be estimated using a mass balance method and verified with procedures audits, until a final decision is reached on the accuracy and reliability of these alternative methods.

- Due to technical difficulties encountered in operating the FGMs units, the original compliance dates specified in the Director's Order were amended, on February 10, 1992. This revised schedule is to allow the corporation to resolve the FGMs technical and operating problems.

5.0 AUDIT FINDINGS FOR 1991

The auditors have confirmed that the reported emissions for 1991 from the metallurgical companies and Ontario Hydro were reliable, accurate and verifiable. The auditor also confirmed that the 1991 emissions from the metallurgical companies were within the limits as required by their respective Ontario Regulations (Regulations 660/85, 661/85 and 663/85). In the case of Ontario Hydro, the audit also confirmed that both SO_2 and NO emissions were within the limits for 1991 as required by Ontario Regulation 355/90 (formerly O. Reg. 281/87).

The following table summarises the 1991 SO_2 and NO emissions and associated accuracy.

1991 SO_2 EMISSIONS (KILOTONNES)

Sources	Legal Limit	Actual Emissions	Accuracy (%)
INCO Limited	685	572	Not Available
Falconbridge	154	63.6	6.8
Algoma (Wawa)	180	52.7	6.7
Ontario Hydro	240	166	3.7
Ontario Hydro (SO_2+NO)	280	223	3.0

5.1 INCO Limited

The auditor has confirmed that the company's 1991 SO_2 emissions from the Copper Cliff and Nickel Refinery smelting operations were 572 kt. The procedures audit determined minor deviations from the Procedures Manual SO_2 emissions estimating method. These minor deviations have been corrected and the improvements recommended by the auditor have been implemented. Further, the company is fine tuning the method for determining the overall uncertainty of the reported annual SO_2 emissions.

Highlights of the Auditor's Report:

The auditor, Price Waterhouse[3], confirmed that the reported SO_2 emissions were based on materials sampling, weighing, assaying and calculating methods described in the Procedures Manual.

The auditors did not comment on the uncertainty of the reported SO_2 emissions since the statistical analysis method had not been completely accepted by the Ministry.

The auditor noted 12 deviations from the Procedures Manual and provided three suggestions and seven recommendations to improve the SMB determination. These 12 deviations concern: matte sampling and assaying, duplicate assaying, re-calibrating and testing of liquid SO_2 tank car scale, providing information on the new acid plant, checking manually copper and nickel concentrate calculations, and performing iron and silica balance around the nickel smelter.

Government Review of the SO_2 Emissions Audit

- INCO's 1991 SO_2 emissions of 572 kt were about 16% below the limit of 685 kt set for the period 1986-1993 inclusive but more than twice the limit of 265 kt set for Dec. 31, 1994 by the Regulation 660\85. The company is expected to meet the emission limit requirement for December 31, 1994 through the new smelter process changes.

- The Ministry has requested that the 1992 SO_2 emissions audit include an evaluation on the estimated statistical uncertainty of the annual emission at the 95% confidence level.

- The company has agreed to implement the audit recommendations before the 1992 annual SO_2 emissions audit.

- The Procedures Manual will be revised to include a description of the new smelting process and acid plant, and bulk concentrate smelting operations.

5.2 Falconbridge Limited

The auditor has verified that the Company's reported 1991 SO_2 emissions of 63.6 kt was accurate, with an overall uncertainty of ±6.8%, at the 95% confidence level. The auditor noted minor variances with the SMB procedures, as described in the Procedures Manual. These deviations have been corrected and the auditor's recommendations will be implemented before the 1992 audit.

Highlights of the Auditor's Report:

- The audit by Hatch Associates Ltd.[4] confirmed that the SO_2 emissions reported by Falconbridge Limited for 1991, were calculated as per the procedures manual. However, there were some variations and these were listed in the 1991 audit report.

- Sulphur analysis verification of the randomly selected samples of concentrate, electric furnace slag and matte were in agreement with the original analysis determined by the company.

- The auditors noted three major areas of concern in the 1991 SO_2 emissions audit as follows:

  (i) subjective and imprecise techniques were used in determining the acid weight;

  (ii) procedures used for determining the concentrate feed rate were deficient;

  (iii) sulphur analysis methods were switched without providing proper documentation.

- Minor deviations related to the sulphur determination of the roaster feed concentrate, matte and by-products were noted. Further, deficiencies in documenting the SMB procedures were also noted.

- Deficiencies in the documentation prevented the complete verification of the SMB calculations.

- Recommendations were made to improve the input and output streams determinations used in SMB calculations.

Government Review of 1991 SO_2 Emissions Audit

The procedures audit by Hatch Associates Ltd. confirmed that the 1991 SO_2 emissions of 69.6 kt were in compliance with O. Reg. 661/85. These emissions are about 55% less than the 1991 limit of 154 kt and 30% below the December 31, 1994 limit of 100 kt.

- The company has agreed that the deviations noted in the 1991 SO_2 emissions procedures will be corrected or improved, with particular emphasis on roaster feed and acid weight determinations, before the next audit.

5.3 Algoma Steel Inc. (WAWA OPERATIONS)

The auditor confirmed that the company's reported 1991 SO_2 emissions of 52,715 tonnes were accurate within ±6.7% of the calculated value, at the 95% confidence level. The improvements recommended by the auditor will be implemented before the next audit.

Highlights of the Auditor's Report:

- The audit by Rowswell and Associates Engineers Ltd.[5] confirmed that there were no major variations noted from the Procedures Manual.
- The company has developed a Quality Assurance and Quality Control (QA/QC) program for assaying sulphur in both the blended ore and sinter using Leco and X-ray spectrometer methods. The QA/QC program for the sinter has been implemented while the QA/QC for blended ore is being implemented.
- The company has made improvements to minimize the errors in the feed sampling and analysis of sulphur content.
- The auditor noted the following concerns:
  - (i) the accuracy of the annual SO_2 emissions was reduced due to the poor tracking of the main ore, oxide and limestone feed belt (T-14 and associated weigh scale). This condition could result in an uncertainty of ±5% instead of the manufacture's specified uncertainty of ±2%.
  - (ii) maintenance's records of conveyors and weigh scales were not available.

Government Review of 1991 SO_2 Emissions Audit

- The auditor confirmed that the reported 1991 SO_2 emissions of 52.7 kt were in compliance with O. Reg. 663/85. This emission estimate is about 71% less than the limit set for the period 1990-1993 and 58% lower than the limit set for December 31, 1994.
- The main blended ore feed conveyor belt (T-14) must be re-aligned.
- Maintenance work on the conveyor belts and weigh scales must be documented for the next audit.

5.4 ONTARIO HYDRO

The 1991 audit confirmed that the reported SO_2 emissions of 166 kt was accurate within ± 3.7% and the total acid gas emissions (SO_2 and NO) of 223 kt was accurate within ± 3.0%. The SO_2 and acid gas emissions were audited for each quarter of 1991. Except for the NO versus load curves not being updated annually, there were no other major deviations from the Procedures. The auditor's recommendations for improving the accuracy of the reported SO_2 and acid gas emissions have been implemented.

Highlights of the Auditor's Report:

Angus Environmental Ltd. conducted SO_2 and total acid gas (SO_2 and NO) emissions audit of the fossil fuel generating plants, diesel generators serving remote communities and standby combustion turbines at both fossil and

nuclear generating plants for each quarter in 1991. The uncertainty for the quarterly SO_2, NO and total acid gas emissions ranged from 3.2% to 9.2%, 6.8% to 7.9% and 3.0% to 7.2%, respectively. However, total emissions were more accurate than each component. Except for the first quarter audit of the 1991 emissions, the NO uncertainty was generally higher than that for SO_2 emissions.

- The auditor confirmed that the SO_2 and total acid gas emissions for the year 1991 were calculated according to the procedures manual and no major variations have been noted.

(i) SO_2 Emissions and Review of Estimation Methodology

- The auditor confirmed that 98.4% of 1991 SO_2 emissions resulted from coal fuel combustion generation.
- The auditor recommended that future audit of coal consumption be augmented to increase the sample data base and that any errors found be extrapolated to the entire quarter.
- The auditor recommended that duplicating the coal analysis be continued and performed by CANMET. Further, the frequency of the laboratory review program should be reduced to once or twice per year.
- The auditor recommends that a specific program be developed to update the sulphur content retained in the coal ash.

(ii) NO Emissions and Review of Estimation Methodology

- The auditor confirms that 96.6% of NO emissions resulted from coal fuel combustion generation.
- NO concentration curves describing the relationship between the level in the flue gas and boiler load were not updated in 1991. The auditor recommends that the NO curves be updated to facilitate NO emissions auditing.

(iii) General Comments on Emissions Audit

- The auditor recommends that the calorific value determination procedure be discontinued in future audits.
- The auditor recommends that the load distribution matrix and the acid gas emissions estimation program be updated to eliminate the small bias error in the NO emissions estimating methodology.
- The auditor has determined several data handling and calculation errors during the quarterly audits. The auditor recommends that the oral reporting system be replaced with an electronic data handling system.
- The SO_2 and NO emissions estimates of the uncertainty were statistically evaluated for accuracy.

Government Review of 1991 Acid Gas Emissions Audit

- Ontario Hydro 1991 SO_2 and acid gas emissions of 166 kt and 223 kt were in compliance with O. Reg. 355/90 requirements and were

approximately 31% and 20% below the limits set for 1990-1993, and 5% below and 4% above the 1994 limits, respectively.

- The 1991 reported uncertainty of ±3.7% and ±3.0% for SO_2 and acid gas (SO_2 and NO) emissions, respectively, were acceptable.

- The auditor's recommendations must be implemented before the next SO_2 and acid gas emissions auditing program.

- The NO versus load curves for all operating boilers must be updated within a reasonable time frame to facilitate the auditor's verification of the accuracy of future NO emissions.

6. FUTURE DIRECTIONS

All four emitters have expressed concerns regarding these audits. These concerns relate to mass balance procedures audit cost (consultant fees, travel costs, etc.) and staff involvement. Some metallurgical companies feel that these audits should be performed by Ministry staff. Ontario Hydro has concerns regarding the submission of quarterly acid gas emission audit reports using CEM systems or mass balance methods while compliance with the regulation is determined by estimates of annual SO_2 and total acid gas emissions. The metallurgical companies also argued that once the mass balance program is established and the procedures are acceptable to the Ministry, there is no need for an on-going auditing program.

The Ministry considers auditing programs necessary to verify the accuracy and reliability of the reported emissions. These auditing programs are also necessary to meet the Provincial Auditor requirements. Reporting accurate SO_2 and NO emissions is required to meet Federal/Provincial agreements (accord signed by seven provinces east of Saskatchewan/Manitoba border in 1987). The March 1991 Canada/United States Air Quality Accord further requires accurate SO_2 emissions estimates for each Province in Canada. Further, auditing programs are necessary to provide substantiation of the acid gas emissions quantities as stricter and reduced annual emission limits are imposed.

As determined earlier by the Ministry's sub-committee, there are various options available for ensuring accurate SO_2 and NO emissions reporting. Procedures auditing by Ministry staff would be overwhelming and presently, could not be performed along with other MOEE commitments. Also, the current budgetary restraints will not allow hiring of new personnel to conduct in-house acid gas emissions audits. Therefore, this option is not viable and is inconsistent with the polluter pay principle adopted by MOEE.

Alternatively, continuous emission monitoring could be used to report SO_2 and NO emissions. CEM systems have been in use in the United States for the past 20 years to meet New Source Performance Standards (NSPS). In the past 10 years, these CEM systems have significantly improved in accuracy for measuring SO_2 and NO concentrations and are considered reliable. Although most of the CEM systems have been developed for monitoring utility boilers' SO_2 and NO emissions in the U.S., some smelters in the states of Texas and Arizona are reporting SO_2 emissions using these systems. In the Province of Ontario, the installation of these CEM systems for reporting emissions quantities has not been required. INCO has been using these systems for SO_2 emissions estimation and production cutbacks to meet ground level SO_2 concentration limits, as required by Control Orders. Hydro also plans to use this system to optimize the fuel combustion process, minimize NO emissions and improve thermal efficiency (fuel economy).

The three emitters (viz. Inco, Falconbridge and Ontario Hydro) are conducting feasibility studies to determine the viability of adapting CEM systems to

monitor and report SO_2 and NO emissions on a continual basis. With CEM systems in operation, the Ministry would be in a position to audit SO_2 and NO emissions without the need of an outside consultant. However, the emitters will need extra time to study, develop and implement CEM systems in accordance with the requirements of U.S. EPA 40 CFR 60 or the recent version 40 CFR 75 (published in January 11, 1993 Federal Register). Ontario Hydro is in the process of installing flue gas monitors to continuously monitor SO_2 and NO emissions. However, until CEM systems are fully functional, the four major emitters will continue using mass balance estimating methods, with procedural audits undertaken at least once per year by an independent consultant.

7. SOURCES OF INFORMATION

1. Ministry of the Environment Control Program Report of the Audit, Office of the Provincial Auditor (1987).

2. U.S. Environmental Protection Agency, Code of Federal Regulations, Title 40, Part 60, (U.S. EPA CFR 60) Appendix A, B and F. (July 1989)

3. INCO Limited - Ontario Division: SO_2 Emission Procedural Audit Report for the year ended December 1991 by Price Waterhouse (February 2, 1992).

4. Audit of Reported SO_2 Emissions from the Falconbridge Smelter for 1991 by Hatch Associates Ltd. (May 3, 1992).

5. Audit of Annual SO_2 Emissions for the year 1991 for Algoma Steel Inc. Ore Division (Wawa, Ontario) by Rowswell And Associates Engineers Ltd. (April 1992).

6. Procedural Audit of Ontario Hydro's Measurement Methodology for Acid Gas Emission Estimates for Fourth Quarter 1991 and for 1991 annual emission by Angus Environmental Ltd. (May 1992).